Teaching at the University Level

Steven Zucker

One of the ironies of being a college educator in the United States is that one is often rewarded for *not* doing one's job. That sounds like a strange thing to say, but I know that it is true.

I received my Ph.D. in 1974. I taught at state universities (Rutgers and Indiana) before moving to Johns Hopkins in 1983. When I arrived at Rutgers as a fresh Ph.D., I had little teaching experience, and the first few years were trying. Once, I was criticized for covering the entirety of the math department's syllabus for a calculus course when the students were not "getting" some of the topics along the way (I was expected to "put the heart before the course"). I eventually learned to accept the pretenure save-your-own-hide advice that I give to assistant professors: teach so as to keep your ratings up. From then on, I had good student evaluations. But was I a good university educator? Were the students learning better? Not really. Did anyone care? *Not really*. At universities where the standard for reappointment and promotion was quality research and acceptable teaching (or even entirely a research standard), it is obvious why few people wanted to rock the boat over educational matters. The goal was de facto to concentrate one's energies on research and do enough in teaching to keep the students from complaining. That it kept many of them ignorant was not at issue.

When I moved to Hopkins, I got as a bonus an improved environment for teaching. Here was a body of students with a rather high mean SAT math score (now around 700). Believing that they would be a better audience (despite the large class size), I felt that I could comfortably blend into the style that had emerged from my years as assistant professor some of my ideals about teaching calculus to science-oriented students. However, as years went by I started to feel increasing resistance—balking—on the part of a large portion of my class. Since I also felt that my presentation was getting clearer, I became correspondingly irritated over their apparent refusal to take the course seriously. And when I took part in the student-run course evaluation survey a few years ago, I discovered that the class as a whole rated me only "satisfactory". What was going on? It took a poke from my department chair and a couple of years of exertion on my part to arrive at the conclusion that I now hold. The answer is so obvious that it is embarrassing.

The fundamental problem is that most of our current high school graduates don't know how to *learn* or even what it means to learn (a fortiori to understand) something. In effect, they graduate high school feeling that learning must come down to them from their teachers. That may be suitable for the goals of high school, but it is unacceptable at the university level. *That the students must also learn on their own, outside the classroom, is the main feature that distinguishes college from high school.*

My contention is that it is possible to get college freshman to learn calculus fairly well, without resorting to utopian tricks such as enforced group projects. All we have to do is get the student to accept that learning is something that will take place mostly outside of class; that is, *just insist that they grasp the underlying premise of college education*. You may wish to ask yourself where, when, and how freshmen at your university get this message.

It seems to me that the right way to do things is to put a little effort into explicitly and immediately bringing the students' expectations up to university level. I have tried this in the first week

Steven Zucker is professor of mathematics at Johns Hopkins University. His e-mail address is sz@math.jhu.edu.

of my own course (Calculus II for Physical Science and Engineering, fall semester '95—I taught the same course in fall '93 and fall '94) with much success, despite the inevitable dilution of effort that results from our first-semester freshman pass-fail. It helped that my message was reinforced by my department's new "Survival Guide", which was passed out in all basic courses at the beginning of the semester. The class did rather well on exams that were deemed difficult—I prefer "thorough"—by my colleagues. We should be putting our effort into reforming the *students*, not the calculus! My personal attempt at orientation was based on a collection of handouts. At the end of the semester, I saw that I could write up their effective content on *one* page; it is appended to this article.

I'm told by students that during that first week, most of the class was thinking "Strange. Why was our professor going on like that?" It eventually dawned on me that this sort of academic orientation should have been getting carried out by the organizers of Orientation Week, who now put all of their efforts only into making students socially at ease the week before classes begin. After all, isn't how to study in college something important that most freshmen don't know when they arrive? Still, they will be expected to have figured it out by the end of the academic year (not necessarily without pain). Why is this important piece of wisdom concealed from our entering students? And why do serious educators have to endure the consequences of receiving a batch of students with expectations at the high school level?

When college students act as though they are still in high school, they rate their professors accordingly. If it is even suspected that the ratings will be taken nearly at face value, as I fear they too often are these days, a prudent instructor will then be tempted to make his or her courses more like high school. A serious instructor with ambition will probably end up absorbing the consequences of mediocre ratings. Thus, the teaching of basic university mathematics at the college level becomes the thankless task of the idealist. We must hold the system responsible for encouraging the behavior that it rewards and ourselves for allowing such a system to persist.

We let them stay in high school for several reasons. One is the fear of negative teaching evaluations! It's a vicious circle. To get good evaluations, one can simply give the students what most of them (think they) want: a course where the material moves slowly and can be picked up largely in the classroom, exams that reflect a predetermined list of problem types. Careful preparation and a few drops of avowed concern completes this recipe for an "A" rating with students. And I've never heard more than a handful of students complain that a course was too easy!

Another reason for letting them stay in high school is that we may opt to take the path of least resistance. It takes a lot of time and energy on the instructor's part to prepare and deliver lectures and to make up and grade suitable exams that will help the students attain the goal of command of the material. And it requires emotional strength to hold one's stance when some of the students show signs of strain while at the same time giving help to the students during office hours and beyond. In short, it is pragmatic to teach so as to keep one's ratings up and to leave the standard near the high school level.

I used to be hoodwinked by the notion that it was unfair to test the students on anything I didn't "go over" in class, even when problems were assigned in the homework. I feel now that it was an unwarranted concession to their intent to stay in high school. Why are we rewarding their resistance? At Hopkins one of our finest graduate student teaching assistants taught calculus in the summer session. One of her students had the *gall* to assert in the course evaluation survey that he or she could not recommend her: the TA had had the effrontery to ask the class to pick up one of the last topics on their own.

One of my basic tenets is that the students have no right to know what an upcoming exam is going to look like. (However, exams from previous years are on file at the library.) I aim to prepare them for *any* reasonable exam I might come up with. That is, I'm asking them to aspire for command of the material of the course and not any particular subset of it. Some students think this is "unfair"—it wasn't like that in high school—when in actuality asking for a sneak preview of the exam is nothing but attempted cheating. When the instructor helps them cheat, the students reward him or her with higher marks on the evaluation survey for giving "fair" exams and "relevant" lectures, and the community ends up with the impression that the instructor is a good teacher. I think I've made a good case that such people should be *reprimanded*, not lauded, for they contribute to the undermining of education at the college level. (The reader may be able to anticipate the corollary that one cannot measure the level of a course just by looking at the exams: an exam that looks "hard" may cease to be so if the students had been told by the instructor to expect those problems or ones just like them.)

Naturally, an instructor who plans the lectures carefully and delivers them well will rate better than one who does not; that is appropriate. I'm only trying to enunciate a point that every math professor surely knows, at least subconsciously: other things being equal, an easy

course will rate higher than a demanding one. This factor is not treated in most course evaluations. (Indeed, I doubt that a reliable measurement of learning can be achieved by simply polling the students at the end of the semester.) Students, especially freshmen, can and do declare that an instructor is hard to follow just because the material is not presented and reinforced completely in the lectures, *even when the students who keep up with their share of the work assert that the material is being explained very clearly*.

In conclusion, I think I have illustrated how the issues of academic orientation, the serious evaluation of teaching, and the "calculus crisis" are linked, at least at selective universities like Johns Hopkins. Of course, the way in which mathematics education in any particular college or university can be improved depends on the composition of its student body. The overall theme should be the same though. Students must be told *immediately* that they are about to face a big jump in level from high school. Most high school teaching is justifiably set to the needs of the least talented students in the class; the better students often become convinced by habit that this level is right for them too. They should be helped to recognize that the change is both appropriate and manageable. It is not necessary for their teachers to "program" them, for they are quite capable of monitoring their own learning. It is not necessary for them to grasp things at once from the classroom presentation alone, for many things require time and effort for attainment of the level of understanding we would like them to achieve. And most of that can take place only outside of the classroom.

Academic Orientation for Fall Semester Freshman Lecture Courses

What follows is what an entering freshman should hear about the academic side of university life. It is distilled from what I've learned and written concerning the need for academic orientation as a result of having been the instructor of 110.109 (Calculus II: Physical Sciences) in the fall semester for three consecutive years.

The underlying premise, whose truth is very easy to demonstrate, is that most students who are admitted to a university like JHU were being taught in high school well below their level. The intent here is to reduce the time it takes for the student to appreciate this and to help him or her adjust to the demands of working up to level.

1. **You are no longer in high school**. The great majority of you, not having done so already, will have to discard high school notions of teaching and learning and replace them by university-level notions. This may be difficult, but it must happen sooner or later, so sooner is better. Our goal is more than just getting you to reproduce what was told to you in the classroom.
2. Expect to have material covered at *two to three* times the pace of high school. Above that, we aim for greater command of the material, especially the ability to apply what you have learned to new situations (when relevant).
3. Lecture time is at a premium, so it must be used efficiently. You cannot be "taught" everything in the classroom. **It is *your* responsibility to learn the material**. Most of this learning must take place *outside* the classroom. You should be willing to put in two hours outside the classroom for each hour of class.
4. The instructor's job is primarily to provide a framework, with *some* of the particulars, to guide you in doing your learning of the concepts and methods that comprise the material of the course. It is not to "program" you with isolated facts and problem types nor to monitor your progress.
5. You are expected to read the textbook for comprehension. It gives the detailed account of the material of the course. It also contains many examples of problems worked out, and these should be used to supplement those you see in the lecture. The textbook is not a novel, so the reading must often be slow-going and careful. However, there is the clear advantage that you can read it at your own pace. Use pencil and paper to work through the material and to fill in omitted steps.
6. As for *when* you engage the textbook, you have the following dichotomy:

   a. [*recommended for most students*] Read for the first time the appropriate section(s) of the book *before* the material is presented in lecture. That is, come prepared for class. Then the faster-paced college-style lecture will make more sense.

   b. If you haven't looked at the book beforehand, try to pick up what you can from the lecture (absorb the general idea and/or take thorough notes) and count on sorting it out later while studying from the book outside of class.

7. Exams will consist largely of fresh problems that fall within the material that is being tested.